Tyilbuingunyinbaiap, we three beat. It will be apparent that the words *baiap* or *kullik* are merely superadded to the suffix of the plural.

In the Motu, one of the languages of New Guinea, Rev. W. G. Lawes reports that the dual and trial of pronouns are formed by additions to the plural.[1]

If a line be assumed to be drawn on the map of Victoria from Melbourne to Echuca, then the whole of that portion of Victoria situated on the eastern side of that line has no trial number in its speech, but in all the languages to the west of that line the trial number obtains.

ADVERBS AND PREPOSITIONS.

In principle these resemble the same parts of speech in the Murawarri and Gundungurra, and some of them take similar inflexion for number and person.

Interjections and exclamations are not numerous and have been omitted.

NUMERALS.

One, yuwaia. Two, bulle. Several, girtāwal.

A NEW FRESH-WATER MOLLUSCAN FAUNULE FROM THE CRETACEOUS OF MONTANA.

(Plate IV)

BY TIMOTHY W. STANTON.

(*Read April 3, 1903.*)

An interesting collection of fresh-water invertebrate fossils, collected in Montana by a recent expedition from the Geological Department of Princeton University, has been placed in my hands for study through the courtesy of Prof. W. B. Scott and Dr. A. E. Ortmann. Although the collection contains only half a dozen species, it is of more than usual interest on account of the excellent preservation of the fossils and the fact that they probably come from either a new horizon for fresh-water mollusks, or at least a new

[1] *Motu Grammar* (Sydney, 1896), p. 9.

basin, as is indicated by their apparent distinctness from all described species.

According to the labels the fossils all come from one locality on Wettacombe's ranche near Harlowton, on the Musselshell River, Montana, where they were collected by Dr. M. S. Farr and Mr. A. Silberling. The interesting Mesozoic and Tertiary section of this region lying in Sweetgrass county, east of the Crazy Mountains and south of the Big Snowy Mountains, has been somewhat fully described by Mr. Earl Douglass,[1] who states that the Fort Union, the Laramie and the familiar Meek and Hayden section of the marine Upper Cretaceous are well represented. Beneath the Fort Benton formation is a thick series—"many hundreds of feet"—of sandstones and shales, of which the upper part is supposed to represent the Dakota and the lower part—"largely red in color"—yielded bones of large Dinosaurs, fossil wood and these invertebrates. Douglass refers this part of the section with doubt to the Jurassic, though he states that the vertebrate remains have not been studied. I have not been informed as to whether the mollusks and vertebrates occur in exactly the same bed. Apparently the exposure does not extend to beds as low as the marine Jurassic, which is known to occur in this general region, and which belongs to the upper part of the Jurassic system.

It is evident from the above statement that the fresh-water horizon in question lies somewhere between the marine Upper Jurassic and the Fort Benton, which may be correlated with the Turonian of Europe. This interval, covering the lower part of the Upper Cretaceous, all of the Lower Cretaceous and possibly the latest Jurassic, is not represented by marine strata in the northern interior region. Instead there is a number of non-marine formations in various parts of the region, whose relationships to each other are obscure, their principal point of resemblance in most cases being an apparently similar stratigraphic position.

Since in other parts of the continent this interval includes the equivalent of the Comanche series, consisting of several thousand feet of marine sediments and containing a number of distinct faunas, it is evident that there is room for many distinct horizons of fresh-water beds, and it would not be surprising if those of different ages were in some cases developed in different parts of the

[1] *Science*, n. s., Vol. XV, pp. 31 and 272, January 3 and February 14, 1902; *Proc. Amer. Philos. Soc.*, Vol. XLI, pp. 207–224, 1902.

large area, so that their exact stratigraphic relations with each other are not observable. It will therefore be necessary to consider the different formations and horizons that have been recognized, in order to make an approximate determination of the age of the fossils now under consideration.

In southern Wyoming the marine Jurassic is immediately overlain by the Como beds (formerly called Atlantosaurus beds), containing a large reptilian fauna and a considerable number of Unios and other fresh-water shells. Similar beds that are correlated with them by means of the fossils occur in the Black Hills, along the Front Range in Colorado and elsewhere in the Rocky Mountain region. These beds have usually been referred to the Jurassic, though recently several paleontologists have referred them to the Lower Cretaceous. The mollusca are of modern types, mostly belonging to genera that are still represented by living species, but the specific forms are quite distinct from all those found fossil in later beds. Of all the species that have been assigned to the Como horizon only one (*Viviparus gilli* M. and H.) is comparable with a form in this Montana collection, and that one is from a locality near the head of Wind River, Wyoming, where it was associated with *Liaplacodes veternus* M. and H. and *Neritina nebrascensis* M. and H. As none of these three species has been found elsewhere,[1] the age of the bed from which they came is doubtful, and may well be later than the Como.

Two non-marine formations of this general region, the Cascade and the Lakota,[2] have been referred to the Lower Cretaceous. The Cascade formation, which occur in the neighborhood of Great Falls, Montana, is coal-bearing and has been correlated by means of the fossil plants with the Kootanie of the neighboring Rocky Mountain region in Canada, and with the lower Potomac of the Atlantic border. Its geographic position and the apparently similar stratigraphic relations favor the supposition that the fresh-water beds near Harlowton may belong to the Cascade (Kootanie) formation, but unfortunately the former have yielded no plants except fossil wood, and the fauna of the latter is practically unknown. Obscure imprints of Unio have been reported from the Cascade, but nothing sufficiently definite for description. A few undescribed

[1] Logan inadvertently describes *Planorbis veternus* as *Liaplacodes* from the Freeze-out Hills of Wyoming, in *Kansas Univ. Quart.*, Vol. IX, p. 132, 1900.

[2] Named by Weed in the Fort Benton Folio, *Geol. Atlas of the United States.*

fresh-water gastropods have been collected from beds immediately overlying the Cascade and referred by Mr. Weed to the Dakota, and these are of types different from any in the Harlowton collection. That is, they are not specifically comparable.

The Lakota formation is found in the Black Hills region, where it is said to overlie beds correlated with the Como beds, and to underlie the Dakota. It is characterized by a flora, by means of which its Lower Cretaceous age has been determined, and it has been tentatively correlated with a part of the Potomac and by inference also with the Kootanie and a part of the Glen Rose beds. It has yielded no animal remains, and therefore needs no further mention in this connection.

Beds that have been referred to or correlated with the Dakota have a wider distribution than any of the other formations above mentioned. The original area is in northeastern Nebraska on the Missouri River, from which the formation has been satisfactorily traced and identified through Nebraska and Kansas, where it covers considerable areas on the Great Plains. It consists of several hundred feet of coarse sandstone with some shales, passing up into the Fort Benton shales with evident continuity of sedimentation. Paleontologically it is chiefly characterized by its large flora. It has yielded a very few marine and brackish water mollusca, but although it was evidently deposited at or near sea level it seems to have been largely non-marine in character, since a number of localities in it have yielded fresh-water mollusca. The abundant land flora also indicates non-marine conditions. The fauna[1] includes species of Unio, Margaritana, Corbula, Goniobasis, Viviparus and Pyrgulifera, none of which is specifically closely related to the species described in this paper. The Dakota has also been well identified in the Black Hills region and along the eastern base of the Rocky Mountains in Colorado. It has been mapped in many areas farther west in Wyoming, Montana, Utah, and elsewhere, but the correlation is certainly erroneous in some of these areas and must be considered doubtful in many of them, because the identifications have been based entirely on very general comparisons of the lithology and stratigraphy. It has been the general custom to refer to the Dakota any formation consisting in part of conglomerates and sandstones and underlying the

[1] See C. A. White, "Notes on the Invertebrate Fauna of the Dakota Formation," *Proc. U. S. Nat. Mus.*, Vol. XVII, pp. 131–138, 1894.

marine Cretaceous. That the formations thus assigned in many cases include the equivalent of the true Dakota is very probable, but that they may also include other horizons, laid down in the long interval between the Jurassic and the Upper Cretaceous, is equally probable. In the Yellowstone Park and adjacent areas the supposed Dakota includes bands of impure limestone filled with fresh-water shells not found elsewhere. Among them is a Unio represented by rare casts and fragments, but the most of them are simple gastropods, the most common of which I have described as *Goniobasis ? pealei*, *G. ? increbescens* and *Amnicola ? cretacea*.[1] The beds referred to the Dakota near Great Falls, Montana, already mentioned, contain another assemblage of three or four species of fresh-water mollusca not known elsewhere. None of these supposed Dakota beds in the region just mentioned yielded the characteristic Dakota flora.

The Bear River formation of western Wyoming is the last one to be considered in this connection. It consists of a great thickness (as much as 4000 feet in some sections) of conglomerates, sandstones and shales, having a large and peculiar fresh-water fauna. Its principal known area extends from the neighborhood of Evanston, on the Union Pacific Railroad, northward near the western boundary of Wyoming for more than a hundred miles. Originally it was assigned to the Tertiary, afterward to the Laramie, or uppermost Cretaceous. It is now known to lie between the Fort Benton and the marine Jurassic,[2] but just how much or what part of this interval it represents is not positively known. Some of the conglomerates associated with the fossiliferous beds have probably been mapped as Dakota by the early surveys. The occurrence of a few undetermined dicotyledonous plants of modern type in the formation favor its assignment to the Upper Cretaceous. The fauna is not closely related to any other known on this continent, as all the species are restricted to it, and at least two of the gastropod types are so peculiar that they have been described as new genera. The entire fauna has been reviewed and figured by Dr. C. A. White,[3] who has made detailed comparisons with other non-marine faunas. One of the most striking of the common fossils of the fauna is *Pyrgulifera*

[1] *Monog. U. S. Geol. Surv.*, Vol. XXXII, Pt. 2, pp. 632, 633, 1899.

[2] See Stanton: "The Stratigraphic Position of the Bear River Formation," *Am. Jour. Sci.*, 3d ser., Vol. XLIII, pp. 98–115, 1892.

[3] *Bull. U. S. Geol. Surv.*, No. 128.

humerosa Meek, and the genus to which it belongs was not known to occur in America outside of the Bear River formation until a few years ago, when a species apparently referable to it was described from the Dakota of Nebraska, and another undescribed species is now known from the same formation in Kansas. This fact is an additional indication that the Bear River and Dakota are of nearly the same age.

It is worthy of note that the Bear River fauna includes an Ostrea, which proves that the formation was deposited at or near sea level, and that the waters occasionally became brackish, at least locally. The geographic distribution of the older marine formations makes this occurrence of Ostrea still another reason for considering the Bear River an Upper Cretaceous formation.

The six species of invertebrates from near Harlowton will be described on succeeding pages under the following names:

Unio farri.
Unio douglassi.
Campeloma harlowtonensis.
Viviparus montanaensis.
Goniobasis ? ortmanni.
Goniobasis ? silberlingi.

These are all new specific names, and it will be necessary to depend on the known range of the species that appear to be most closely related in attempting to determine the age of the beds from which they came.

Two of the species, *Unio douglassi* and *Campeloma harlowtonensis*, have their nearest relatives in the Bear River formation. *Unio douglassi* is of the same general type as *U. vetustus* Meek and has very similar beak sculpture, though it differs considerably in outline and proportions. *Campeloma harlowtonensis* resembles *C. macrospira* Meek so closely that it is difficult to separate them.

Viviparus montanaensis, as has already been stated, is closely related to *V. gilli* M and H., which has been doubtfully referred to the Jurassic.

The other species of Unio is of modern type, but apparently not very closely related to any known fossil species, while the two forms that are here referred to Goniobasis have a very modern aspect, suggesting Upper Cretaceous rather than older types.

Although the evidence is not fully convincing, the indications are that this fresh-water horizon near Harlowton is not far from the hori-

zon of the Bear River formation—possibly contemporaneous with a part of it—and that it is certainly not older than Lower Cretaceous, and more probably should be assigned to about the base of the Upper Cretaceous.

The facts thus briefly related should call renewed attention to the important and apparently complex history recorded in the non-marine formations of the late Jurassic and early Cretaceous of the Northwest—a history that is as yet far from being fully understood, although it is evident that the deposits contain the record of a great many facts that await the detailed investigation of the region for their interpretation.

Description of Species.

UNIO FARRI n. sp. Pl. IV, Figs. 1, 2.

Shell small, short and relatively convex; beaks somewhat prominent and inflated, situated about one-third the length of the shell from the anterior end, not sculptured nor eroded; dorsal margin nearly straight; ventral margin moderately convex; anterior end regularly rounded; posterior end obliquely subtruncate; umbonal ridges rather prominent, rounded, extending to the postero-ventral angle; surface marked only by moderately prominent, irregularly arranged lines of growth.

The type specimen measures 37 mm. in length, 22 mm. in height, and 16 mm. in convexity of both valves. The largest specimen of the eight in the collection is 45 mm. in length. Three of the specimens are relatively somewhat more compressed and longer and have the posterior end more obliquely truncated. These differences are believed to be sexual rather than specific and are not greater differences than are seen in some living species of Unio. One of these compressed specimens (represented by Fig. 2) measures 40 mm. in length, 22 mm. in height and 13 mm. in convexity.

This species is suggestive of the *parvus* group of living Unios, but is not sufficiently closely related to any fossil species from our Western formation to require detailed comparison.

Locality.—Wettacombe's ranche near Musselshell River, in the vicinity of Harlowton, Montana.

Horizon.—Upper part of Lower Cretaceous or base of Upper Cretaceous.

UNIO DOUGLASSI n. sp. Pl. IV, Figs. 3, 4.

Shell below medium size, elongate, rather slender and moderately convex; beaks small, inconspicuous, situated about one-fourth the length of the shell from the anterior end; dorsal margin nearly straight; ventral margin very gently convex; anterior end regularly rounded; posterior end broadly rounded below and very obliquely subtruncate above, so that its termination is acutely subangular; umbonal region strongly sculptured over an area about 17 mm. long and 7 mm. high, with prominent concentric ribs, crossed on the posterior portion by two sharply elevated, linear, radiating ribs, one of which is on the umbonal ridge and the other midway between it and the postero-dorsal margin. The concentric ribs change their direction abruptly and have their continuity more or less broken in crossing the radiating ribs, especially the upper one. The rest of the shell shows only moderately distinct growth-lines, except on the postero-dorsal area above the umbonal ridge, which shows numerous faint, slightly curved, irregular radiating lines.

An average specimen measures 56 mm. in length, 24 mm. in height and 15 mm. in convexity (both valves), the greatest height and convexity being about midlength of the shell. A few specimens appear to be relatively somewhat more compressed and higher, but this is due, in part at least, to accidental distortion. The species is represented by about forty specimens.

This species closely resembles *Unio vetustus* Meek from the Bear River formation in all the details of sculpture, but it differs from that species in its smaller size and much more slender form.

Locality.—Wettacombe's ranche near Musselshell River, in the vicinity of Harlowton, Montana.

Horizon.—Upper part of Lower Cretaceous or base of Upper Cretaceous.

VIVIPARUS MONTANAENSIS n. sp. Pl. IV, Fig. 5.

Shell small, rather stout, subovate, consisting of about five rapidly increasing whorls; volutions rounded below and obtusely subangular and flattened above, so that they are more or less distinctly shouldered; last volution slightly expanded at the aperture, which is broadly ovate; outer lip simple, nearly straight in profile outline; inner lip moderately thick, closely appressed to the shell above, very slightly elevated and reflexed below; surface bearing only very fine lines of growth.

The figured type, which is of about the average adult size, gives the following measurements: Height, 12 mm.; greatest breadth, 10 mm.; height of aperture, 7 mm.; breadth of same, 5 mm. The collection contains about two hundred specimens, which show little variation except in size. Part of the specimens, supposed to be immature, are considerably smaller than the type.

This species is very similar in general appearance to *Viviparus gilli* Meek and Hayden, which was described[1] from beds provisionally referred to the Jurassic at the head of Wind River, Wyoming, but it differs from the Wyoming form in being slightly smaller, and in having more distinctly shouldered whorls, a more oblique aperture, and with the inner lip more closely appressed to the shell and not so prominent.

Locality.—Wettacombe's ranch near Musselshell River, in the vicinity of Harlowton, Montana.

Horizon.—Upper part of Lower Cretaceous or base of Upper Cretaceous.

CAMPELOMA HARLOWTONENSIS n. sp. Pl. IV, Figs, 11, 12.

Shell large, elongate subovate, consisting of about six elevated convex whorls, separated by a linear impressed suture; aperture large, ovate; inner lip moderately thick, forming a rather heavy callus on the shell above and slightly reflexed below, so as to partly cover the small umbilical depression or chink; surface marked only by fine, slightly sigmoid lines of growth.

The type, which is the largest specimen in the collection, measures 63 mm. in height (with apex restored) and 38 mm. in greatest breadth; height of aperture 34 mm. and breadth of same 23 mm. The other figured specimen is 57 mm. in height (with apex restored), 38 mm. in breadth, and the corresponding dimensions of the aperture are 29 mm. and 22 mm. respectively.

This second specimen shows other differences in the aperture besides its relatively greater breadth, the inner lip being thicker and not so closely applied to the preceding whorl above and having a larger umbilical depression uncovered below. These variations are probably all accidental, as there is distinct evidence of injury to the shell during the life of the animal, shown by a repaired break nearly parallel to the outer lip and a few millimeters from it.

[1] *Palaeont. of the Upper Missouri*, p. 115, Pl. V, Fig. 3, *a*, *b*, Washington, 1865. Figured also by White in Bull. No. 29 and in *Third Ann. Rept. U. S. Geol. Surv.*

There are seventeen other less perfect specimens in the collection, all of which agree fairly well with the type so far as their characteristics are preserved.

This species is very closely related to *Campeloma macrospira* Meek,[1] and may prove to be not more than a variety of that species from the Bear River formation in western Wyoming. Comparison of *C. harlowtonensis* with the type and with a large suite of specimens from the same horizon in Wyoming show that Meek's species averages considerably smaller, and that it is somewhat more slender, with the sutures slightly more oblique and the last whorl relatively larger. The last-named peculiarities cause a greater difference in the aspect and proportions of the shells than would be indicated by measurements. There are also differences in the form of the inner lip. There are, however, associated with the typical form of *C. macrospira* a few specimens that approach more closely to the form here described, and this fact suggests the question whether there are really two species, or only varieties of one variable species.

Locality.—Wettacombe's ranch, near Musselshell River, in the vicinity of Harlowton, Montana.

Horizon.—Upper part of Lower Cretaceous or base of Upper Cretaceous.

GONIOBASIS? ORTMANNI n. sp. Pl. IV, Figs. 7–10.

Shell small, moderately slender, consisting of about six convex whorls; aperture elongate ovate, slightly produced below; inner lip somewhat thickened, closely appressed to last whorl above, slightly reflexed below so as to partly cover the small umbilical chink; surface bearing inconspicuous growth-lines, usually crossed by a variable number of much more prominent sharply elevated spiral lines, which in some cases are strong enough to be called small carinæ. Specimens which may be considered to have the average or typical sculpture show four spiral lines on the whorls of the spire, with about six additional on the base of the last whorl

[1] Named by Meek in a list without description in *Rept. U. S. Geol. Surv. Terr.*, for 1872, p. 478. Described in 1877, *U. S. Geol. Expl. 40th Parallel*, Vol. IV, pt. 1, p. 180, with figures of a small shell doubtfully referred to the species. Figures of Meek's original type are published by White, *Twelfth Ann. Rept. U. S. Geol. Surv. Terr.*, Pl. 30, Fig. 2*a*; *Third Ann. Rept. U. S. Geol. Surv.*, Pl. 8, Figs. 6, 7, and *Bull. U. S. Geol. Surv.*, No. 128, Pl. 10, Figs. 2, 3.

and sometimes a few finer intermediate lines. A few individuals show five lines on the spire, while others have only three or two. Smooth forms like that represented by Fig. 10 usually show incipient spiral lines on the last whorl.

Height of an average specimen, about 17 mm.; greatest breadth, 8 mm.; height of aperture, 7 mm.; breadth of aperture, 5 mm.

The most striking feature of the species is the variability of its sculpture, though in this respect is comparable with such living species as *G. virginica* Gmelin. Of about 200 specimens in the collection nearly half either lack spiral sculpture or have it very faintly developed.

The generic reference of Goniobasis is not entirely satisfactory, as the aperture differs in some respects from typical living species of the genus. It slightly suggests *Lioplacodes veternus* Meek from the supposed Jurassic at the head of Wind River, but it is specifically very distinct and I think not referable to the same genus. In sculpture it resembles *G. tenuicarinata* M. and H. from the Laramie more closely than any other fossil form.

Locality.—Wettacombe's ranch near Musselshell River, in the vicinity of Harlowton, Montana.

Horizon.—Upper part of Lower Cretaceous or base of Upper Cretaceous.

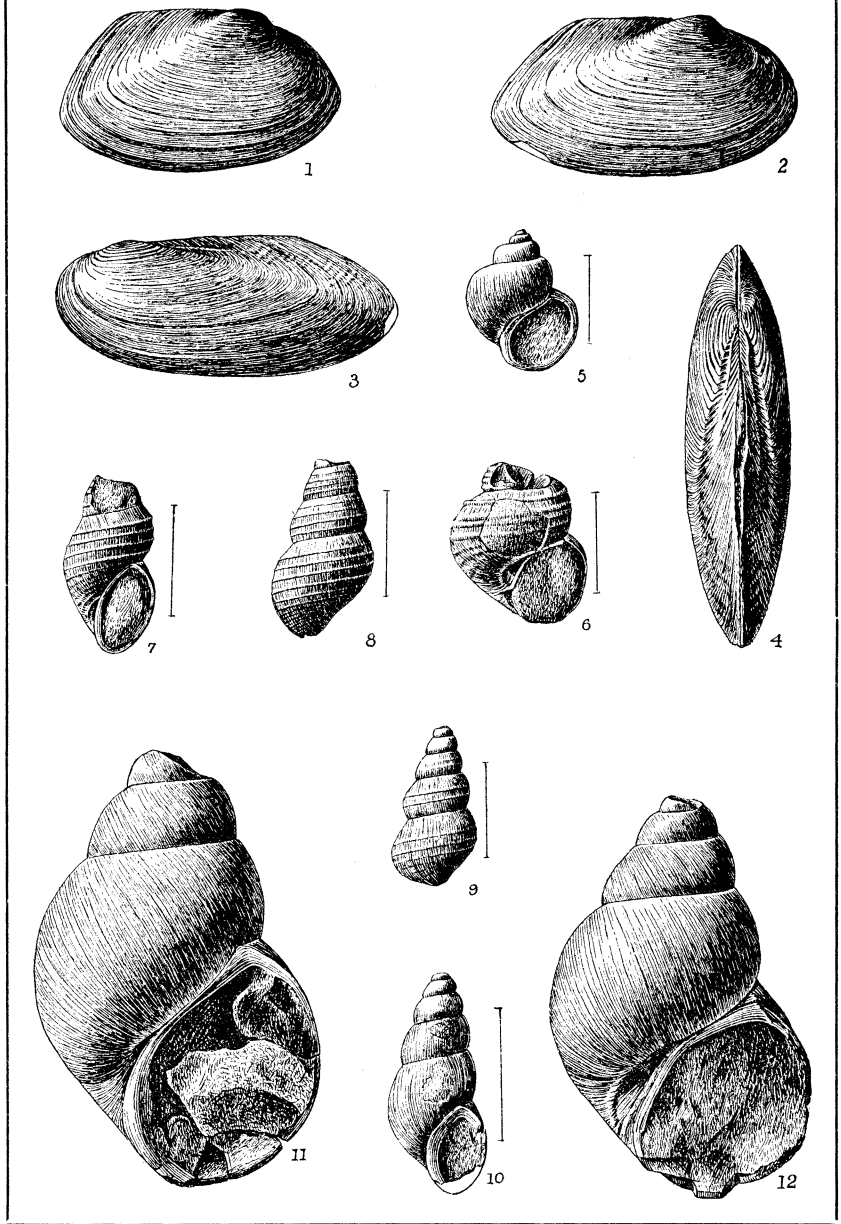
GONIOBASIS? SILBERLINGI n. sp. Pl. IV, Fig. 6.

A single fragmentary specimen associated with the preceding seems to be worthy of description, although the generic reference is very doubtful. It is the basal portion of a shell consisting of nearly two whorls and may be described as follows:

Shell of moderate size, rather stout; whorls very convex; aperture broadly ovate; inner lip thin, slightly reflexed below over a distinct umbilical pit; surface of the spire with four strong spiral ridges or carinæ, which are unequally spaced, the space between the uppermost one and the suture and also between it and its neighbor being broader than the other smooth bands.

The fragment measures 13 mm. in height and 13 mm. in greatest breadth; height of aperture, partly estimated, 9 mm.; breadth of same, 6 mm.

The base of the aperture is broken, and it is possible that the large size of the umbilical pit is due to abnormal individual development. If this is a normal example of the species, it can hardly



STANTON—NEW FRESH-WATER MOLLUSCAN FAUNULE.

be placed in the same genus with *G.? ortmanni*. In sculpture it suggests the carinated forms that White has very doubtfully referred to *Lioplax endlichi* from the Bear River formation.

Locality.—Wettacombe's ranch, near Musselshell River, in the vicinity of Harlowton, Montana.

Horizon.—Upper part of Lower Cretaceous or base of Upper Cretaceous.

EXPLANATION OF PLATE.

Unio farri Stanton.

Fig. 1. Right valve of type.

Fig. 2. Right valve of compressed form, probably male.

Unio douglassi Stanton.

Fig. 3. Left valve of a small specimen.

Fig. 4. Dorsal view of an average-sized specimen.

Viviparus montanaensis Stanton.

Fig. 5. Aperture view of the type, enlarged.

Goniobasis ? silberlingi Stanton.

Fig. 6. Aperture view of the type, enlarged.

Goniobasis ? ortmanni Stanton.

Fig. 7. Aperture view of fragmentary specimen with strong sculpture, enlarged. Outer lip restored from another specimen.

Fig. 8. Dorsal view of a similar specimen, enlarged.

Fig. 9. A specimen with only two spiral lines on the spire, enlarged.

Fig. 10. Aperture view of a specimen without spiral sculpture except on back of last whorl, enlarged.

Campeloma harlowtonensis Stanton.

Fig. 11. Aperture view of the type.

Fig. 12. Similar view of a broader, more umbilicated specimen.

REACTION AS AN EFFICIENT AGENT IN PROCURING DEEPER NAVIGABLE CHANNELS IN THE IMPROVEMENT OF RIVERS AND HARBORS.

BY LEWIS M. HAUPT, A.M., C.E.

(*Read April 2, 1903.*)

Consumption, production and distribution are the three main elements of trade. Without great facilities for distribution it is not possible to maintain a nice adjustment between supply and demand. One section of the earth may be starving, while another may be burning its excess of food for lack of cheap transportation.